Which LOS Algorithm Should be Used as a Standard?

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Background

- On 17 December 2002, LOS Working Group discussed the creation of a LOS algorithm which could be used as a standard for testing
- Important because new algorithms are being developed all the time and should be compared to a known/accepted algorithm

22 Different Algorithms Considered

- Five Grid-based Algorithms
- Six Tinned Algorithms (one algorithm – six polygon budgets)
- Ten Spline Algorithms (two algorithms – five thinning techniques)
- One Blended Algorithm

Methodology

- Create an array which saves the ‘most likely’ answer and compare it to other algorithms
- Reduce the number of algorithms to consider based on agreements
- ‘Most Likely’ is what most of the considered algorithms conclude as the intervisibility (i.e. if 14 of the 22 algorithms calculate the sensor/target as visible, the ‘most likely’ answer is LOS exists)
- Use Portions of the 29 Palms One-Meter Resolution Data Base
- 1317 Sensor/Target Evaluations
- All Sensors were located on grid points in order to minimize differences caused by methodology to determine sensor elevations used by different algorithms

Grid-Based Algorithms

- DYNTACS
- Janus (Old Version)
- Janus (New Version)
- ModSAF (Right Triangles)
- Bresenham (also called Nearest Square Method)

TINned Algorithms

- One Algorithm
- One TINning Methodology
- Six Representations
  - ✓ TIN 2m (75% Reduction in Data)
  - ✓ TIN 4m (94% Reduction in Data)
  - ✓ TIN 6m (97% Reduction in Data)
  - ✓ TIN 10m (99% Reduction in Data)
  - ✓ TIN 15m (99.5% Reduction in Data)
  - ✓ TIN 20m (99.75% Reduction in Data)

Spline Algorithms

- **Two Algorithms: L1 (minimizes least squared error) and L2 Spline (minimizes absolute error)**
- **Five Representations:**
  - ✓ **L1 and L2 (using full data sets)**
  - ✓ **L1-3x and L2-3x (using 89% data reduction)**
  - ✓ **L1-6x and L2-6x (using 97% data reduction)**
  - ✓ **L1-12x and L2-12x (using 99.3% data reduction)**
  - ✓ **L1-24x and L2-24x (using 99.8% data reduction)**

Mixed Algorithm

- Called the Battlefield Terrain Reasoning and Analysis (BTRA) Algorithm
- Designed by David Izraelevitz
- Calculates LOS exactly for a given number of grids and approximates LOS for longer distances
- The algorithm examined all LOS exactly (no approximations)

Analysis of All 22 Algorithms

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Agreement	Algorithm
98.8%	BTRA
98.6%	DYNTACS
98.6%	Janus (Old)
98.0%	TIN – 2m
97.9%	L2
97.7%	L1
97.5%	TIN – 4m
97.2%	L2 – 3x
97.1%	TIN – 6m
97.1%	TIN – 10m
96.1%	ModSAF

Agreement	Algorithm
95.8%	L1 – 3x
95.3%	TIN – 20m
94.7%	Janus (New)
94.4%	TIN – 15m
93.8%	Bresenham
90.9%	L1 – 6x
89.0%	L2 – 6x
86.0%	L2 – 12x
84.8%	L1 – 12x
75.5%	L1 – 24x
68.8%	L2 – 24x

Remove everything less than 90% agreement

Analysis of Best 17 Algorithms

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Agreement	Algorithm
99.2%	BTRA
98.9%	DYNTACS
98.9%	Janus (Old)
98.4%	L2
98.3%	TIN – 2m
98.2%	L1
97.6%	TIN – 4m
97.3%	L2 – 3x
97.2%	TIN – 6m
97.2%	TIN – 10m
96.6%	ModSAF

Agreement	Algorithm
95.9%	L1 – 3x
95.3%	TIN – 20m
94.7%	Janus (New)
94.4%	TIN – 15m
93.6%	Bresenham
90.5%	L1 – 6x

Only L2 and TIN - 2m changed order

Remove everything less than 96% agreement

Analysis of Best 11 Algorithms

Agreement	Algorithm	PLOS
99.2%	BTRA	49.1%
99.0%	DYNTACS	49.0%
98.9%	Janus (Old)	49.4%
98.8%	L2	47.9%
98.6%	TIN – 2m	48.3%
98.6%	L1	47.7%
97.4%	TIN – 4m	49.2%
97.3%	L2 – 3x	50.3%
97.1%	TIN – 6m	48.8%
97.1%	TIN – 10m	48.8%
96.8%	ModSAF	46.9%

Remove everything less than 98% agreement

Analysis of Best 6 Algorithms

Agreement	Algorithm	PL
99.2%	DYNTACS	49.0%
98.9%	BTRA	49.1%
98.7%	Janus (Old)	49.4%
98.6%	L2	47.9%
98.5%	L1	47.7%
98.3%	TIN – 2m	4

DYNTACS and BTRA Differ by 3 LOS Calculations out

Conclusion

- The DYNTACS LOS algorithm provides the best estimate of LOS – several other algorithms provided very similar results
- Historically, DYNTACS has also been the best algorithm when compared to field collected LOS and using high resolution, high accurate elevation data
- DYNTACS has been used for over 25 years of computer simulation
  - ✓ Pure Algorithm
  - ✓ Easy to understand
  - ✓ Easy to implement
  - ✓ Simulation Standard